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(54) Title: GRANULES CONTAINING BOTH AN ENZYME AND AN ENZYME PROTECTING AGENT AND DETERGENT COMPOSITIONS CONTAINING SUCH GRANULES

(57) Abstract

Disclosed are granules containing enzyme and an enzyme protecting agent. These compositions are especially employed in solid detergent compositions. When so employed, the enzyme protecting agent maintains/protects the activity of the enzyme when the solid composition is added to an aqueous solution so as to form a detergent wash medium.

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GRANULES CONTAINING BOTH AN ENZYME AND AN ENZYME PROTECTING AGENT AND DETERGENT COMPOSITIONS CONTAINING SUCH GRANULES

BACKGROUND OF THE INVENTION

1. Field of the Invention.

The present invention is directed to enzyme granular compositions, to detergent compositions employing such enzyme granular compositions and to methods of retarding the loss of enzyme activity in the detergent wash medium. In particular, the enzyme granular compositions employed herein are granules containing both an enzyme and an enzyme protecting agent such as ammonium sulfate.

2. Statement of Art.

In order to improve the cleaning properties of detergent compositions, it is common practice to incorporate one or more enzymes into such compositions. For example, enzymes have been heretofore suggested for use in detergent compositions, e.g., laundry detergent compositions. Such enzymes include proteases, amylases, lipases, cellulases, hemicellulases, β-glycosidases, glucose oxidases, cholesterol oxidases and the like. For example, proteases are generally incorporated into the detergent composition in order to enhance the cleaning ability of the composition against prot in stains on the garments being cleaned, e.g., blood, certain foods, etc. Like-

wise, lipases are generally incorporated in order to enhance the cleaning ability of the detergent composition against lipid stains, e.g., greases, fats, etc; amylases are generally incorporated in order to enhance the cleaning ability of the detergent composition against carbohydrates; whereas cellulases are generally incorporated in order to enhance the cleaning ability of the detergent composition against plant stains, clays and the like as well to enhance the cleaning capabilities, softening and color restoration of the detergent composition for cotton garments. See, for instance, U.S. Patent Nos. 4,822,516 and 4,443,355.

The combination of two or more of these enzymes into a detergent composition has also been suggested. See, for instance, U.S. Patent Nos. 4,435,307 (cellulase and protease) and 4,822,516 (cellulase and another enzyme including protease). When so employed in combination, the different enzymes are generally employed at concentrations sufficient to be effective for their intended purpose.

It is also common practice to incorporate additional components into laundry detergent compositions in order to impart desired properties. For example, such compositions generally contain a surfactant and can optionally contain bleaching agents, fluorescent dyes, redeposition preventatives, solubilizing agents and the like. See, for instance, Columns 10 and 11 of U.S. Patent No. 4,822,516. This reference further discloses that agents, such as ammonium sulfate, which act as collectors (scavengers) and reducing agents for effective chlorine found in water can also be incorporated into the detergent composition. In general, the amount of such agents employed in detergent compositions, including scavengers, is that which is sufficient to achieve the desired effect.

While enzymes have been suggested for use in detergent compositions, there are several complications which interfere with achieving the best cleaning results possible from such detergent compositions. For example, enzymes, particularly fungal cellulases, will gradually lose enzymatic activity in the detergent wash medium over time. Thus, over a period of time in the wash medium, enzymatic activity is significantly less than that found immediately upon formation of the wash medium. While no adequate explanation has been put forward to definitively account for this phenomena, it is apparent that some component(s) of the detergent wash medium either is (are) interfering with enzyme activity or is (are) decomposing and/or modifying the enzyme into inactive or less active forms. In view of the above, it would be particularly advantageous if an enzyme protecting agent could be incorporated with the enzyme so as to minimize loss of enzyme activity over time in the wash medium.

SUMMARY OF THE INVENTION

The present invention is directed to solid granular compositions comprising an enzyme and an enzyme protecting agent. When combined with the enzyme in the solid granular composition, the enzyme protecting agent, having one or more enzyme protecting functional groups, provides resistance to loss of enzyme activity when the enzyme is employed in detergent wash media. That is to say that the enzyme protecting agent retards the loss the enzyme activity (i.e., stabilizes the enzyme activity) in detergent wash media. Accordingly, in one of its composition aspects, the present invention is directed toward a solid granular composition c mprising in granular form, an enzyme and an enzyme protecting agent having one or more enzyme protecting functional groups. Preferably, the enzyme is incorporated into said granules and even more

preferably into the core of the granule whereas the enzyme protecting agent is incorporated into and/or onto said granule.

The granules of this invention are particularly suited for use in detergent compositions. Accordingly, in another of its composition aspects, the present invention is directed toward an enzyme containing detergent composition for use in a detergent wash medium comprising a cleaning effective amount of a surface active agent and granules comprising an enzyme and an enzyme protecting agent.

In one of its method aspects, the present invention is directed toward a method of retarding loss of enzymatic activity in a detergent wash medium which method comprises adding to aqueous solution:

(a) a cleaning effective amount of a surface active agent so as to form said detergent wash medium; and

(b) granules comprising an enzyme and an enzyme protecting agent containing enzyme protecting functional groups wherein said agent is employed in an amount effective to retard the loss of enzymatic activity in the wash medium.

DETAILED DESCRIPTION OF THE INVENTION

The compositions and methods of this invention employ solid granular compositions comprising a combination of an enzyme and an enzyme protecting agent. The enzyme protecting agent is employed in order to protect enzyme activity in the detergent wash medium.

In the present invention, the enzyme and the enzyme protecting agent are generally formulated into solid pellets, granules, grains and the like (hereinafter "granules") wherein the enzyme forms part or all of the core of the granule and inert material(s) are added as a coating which forms a layer around the c re. Suitable

inert material(s) employed in such coatings include polyethylene glycol, titanium dioxide and the like. Additionally, the granule may include materials to reduce the rate of dissolution into the detergent wash medium. Such materials and granules are disclosed in U.S. Serial No. 07/642,596 filed on even date with this application as Attorney Docket No.GCS-171-US1 and entitled "Granular Compositions" and is incorporated herein by reference in its entirety.

The incorporation of the enzyme into the granule is especially useful when a protease is employed in the detergent composition in combination with another enzyme. In such embodiments, incorporation of either the protease or the other enzyme into the core of the granule removes the possibility that protease could contact and inactivate the other enzyme.

The enzyme protecting agent is also incorporated into and/or onto the granule. Such incorporation can take the form of including the enzyme protecting agent in the core of the granule with the enzyme; including the enzyme protecting agent in the coating mix which coats the enzyme core; adding the enzyme protecting agent as a separate coating layer either before or after application of the coating layer, etc. Without being limited to any theory, it is believed that this intimate combination of the enzyme protecting agent with the enzyme allows for maximum utilization of its protecting property. That is to say that by directly combining the enzyme protecting agent into the granules, this agent is able to provide maximum protection in protecting the enzymatic activity of the enzyme in the detergent wash medium.

When such granules are employed, the enzyme generally compris s from ab ut 0.001 to about 50 weight percent of the granules; the enzyme protecting agent preferably comprises from about 0.1 to about 40 weight percent f

the granules; with the balance including inert materials and the like.

Sufficient amount of granules are employed in the detergent composition so as to ensure that the enzyme will be employed in the detergent wash medium at a concentration sufficient for its intended purpose. Such concentrations are well known to the skilled artisan. For example, when the enzyme is a cellulase, the concentration of cellulase in the detergent wash medium will generally range from about 0.1 ppm to about 50,000 ppm; more preferably, from about 1 ppm to about 1,000 ppm; and still more preferably, from about 1 ppm to about 400 ppm. In general, the granules are used in the detergent composition in an amount of 0.002 to 20 weight percent and preferably 0.1 to 10 weight percent based on the weight of the detergent composition.

Suitable enzymes for use in the enzyme granules of this invention are those enzymes previously suggested for use in detergent compositions including cellulases, proteases, lipases, cutinases, and the like. Such enzymes are well known in the art. For example, cellulase are well known and are a multi-enzyme system derived from a microorganism which acts on crystalline forms of cellulose and its derivatives to hydrolyze cellulose and give primary products, glucose and cellobiose. Such cellulases are synthesized by a large number of microorganisms including fungi, gliding bacteria (mycobacteria), actinomycetes and true bacteria. Some microorganisms capable of producing cellulases useful in detergent compositions are disclosed in British Patent
No. 2 094 826A, the disclosure of which is incorporated herein by refer nce. Most cellulases generally have their optimum activity in th acidic or neutral pH range. On the other hand, alkaline cellulas s, i.e., cellulases showing optimum activity in neutral or alkaline media,

are also known in the art. Microorganisms producing alkaline cellulases are disclosed in U.S. Patent No. 4,822,516, the disclosure of which is incorporated herein by reference. Other references disclosing alkaline cellulases are EPA Publication No. 269,977 and EPA Publication No. 265,832, the disclosures of which are also incorporated herein by reference.

As noted above, cellulases produced by microorganisms are multi-enzyme systems and are sometimes referred to herein as "cellulase systems" to distinguish it from the classes and components of cellulase isolated therefrom. Such classes and components are well known in the art and include exo-cellobiohydrolase components ("CBH components"), endoglucanase components ("EG components"), and the like. The CBH components and EG components are known in the art to synergistically interact with each other to provide enhanced activity against cellulose.

Additionally, it is known in the art that cellulase components (fractions) can also be used in the detergent compositions. See, in particular, International Application, WO 89/09259; U.S. Patent No. 4,822,516 (particularly, Column 3, lines 59-62); U.S. Patent No. 4,435,307; and U.S. Serial No. 07/422,814; and the like, the disclosures of which are incorporated herein by reference. Accordingly, as used herein, the term "cellulase" means a cellulase system derived from a microorganism or one or more components isolated from the cellulase system.

The fermentation procedures for culturing cellulolytic microorganisms for production of cellulase are known per se in the art. For example, cellulase systems can be produced either by solid or submerged culture, including batch, fed-batch and continuous-flow processes. Th coll ction and purification of the cellulase systems

from the fermentation broth can also be effected by procedures known per se in the art.

Preferred cellulases for use in this invention are those obtained from Trichoderma reesei, T. koningii, Pencillum sp., and the like. Certain cellulases are commercially available, i.e., CELLUCLAST cellulase (available from Novo Industry, Copenhagen, Denmark), RAPIDASE cellulase (available from Gist Brocades, N.V., Delft, Holland), CYTOLASE 123 cellulase (available from Genencor International, Inc., South San Francisco, CA), and the like. Other cellulases can be readily isolated by art recognized fermentation and isolation procedures.

In addition to cellulase, other enzymes (hydrolases) are well known for their use in detergent compositions. Such hydrolases include carboxylate ester hydrolase, thioester hydrolase, phosphate monoester hydrolase, and phosphate diester hydrolase which act on the ester bond; glycoside hydrolase which acts on glycosyl compounds; an enzyme that hydrolyzes N-glycosyl compounds; thioether hydrolase which acts on the ether bond; and α-amino-acyl-peptide hydrolase, peptidyl-amino acid hydrolase, acyl-amino acid hydrolase, dipeptide hydrolase, and peptidyl-peptide hydrolase which act on the peptide bond. Preferable among them are carboxylate ester hydrolase, glycoside hydrolase, and peptidyl-peptide hydrolase. Suitable hydrolases include (1) proteases belonging to petidyl-peptide hydrolase such as pepsin, pepsin B, rennin, trypsin, chymotrypsin A, chymotrypsin B, elastase, enterokinase, cathepsin C, papain, chymopapain, ficin, thrombin, fibrinolysin, renin, subtilisin, aspergillopeptidase A, collagenase, clostridodipep-tidase B, kallikrein, gastrisin, cathepsin D, bromelin, keratinase, chymotrypsin C, pepsin C, aspergillo-peptidase B, urokinase, carboxypeptidase A and B, and aminopeptidase; (2) glycoside hydrolases (cellulase which is an essential

ingredient is excluded from this group) α-amylase, ß-amylase, glucoamylase, invertase, lysozyme, pectinase, chitinase, and dextranase. Preferably among them are α-amylase and ß-amylase. They function in acid to neutral systems, but one which is obtained from bacteria exhibits high activity in an alkaline system; (3) carboxylate ester hydrolase including carboxyl esterase, lipase, pectiñ esterase, and chlorophyllase. Especially effective among them is lipase.

Trade names of commercial products and producers are as follows: "Alkalase", "Esperase", "Savinase", "AMG", "BAN", "Fungamill", "Sweetzyme", "Thermamyl" (Novo Industry, Copenhagen, Denmark); "Maksatase", "High-alkaline protease", "Amylase THC", "Lipase" (Gist Brocades, N.V., Delft, Holland); "Protease B-400", "Protease B-4000", "Protease AP", "Protease AP 2100" (Scheweizerische Ferment A.G., Basel, Switzerland); "CRD Protease" (Monsanto Company, St. Louis, Missouri); "Piocase" (Piopin Corporation, Monticello, Illinois); "Pronase P", "Pronase AS", "Pronase AF" (Kaken Chemical Co., Ltd., Japan); "Lapidase P-2000" (Lapidas, Secran, France); protease products (Tyler standard sieve, 100% pass 16 mesh and 100% on 150 mesh) (Clington Corn Products, Division of Standard Brands Corp., New York); "Takamine", "Bromelain 1:10", "HT Protease 200", "Enzyme L-W" (obtained from fungi, not from bacteria) (Miles Chemical Company, Elkhart, Ind.); "Rhozyme P-11 Conc.", "Pectinol", "Lipase B", "Rhozyme PF", "Rhozyme J-25" (Genencor International, South San Francisco, CA); "Ambrozyme 200" (Jack Wolf & Co., Ltd., Subsidiary of Nopco Chemical Company, Newark, N.J.); "ATP 40", "ATP 120", "ATP 160" (Lapidas, Secran, France); "Oripase" (Nagase & Co., Ltd., Japan).

The enzyme pr tecting agents employed herein refer to those compounds which, when incorporated in the gran-

ules at a sufficient concentration, will prevent significant loss of enzyme activity over time when these granules are added to a detergent wash medium. Suitable enzyme protecting agents include ammonium sulfate, urea, guanidine hydrochloride, guanidine carbonate, guanidine sulfamate, thiourea dioxide, monoethanolamine, diethanolamine, triethanolamine, amino acids such as glycine, sodium glutamate and the like, proteins such as bovine serum albumin, casein, and the like, etc.

The concentration of the enzyme protecting agent employed in combination with the enzyme in the granule is an amount effective to retard the loss of enzymatic activity in the detergent wash medium, i.e., provide resistance to enzymatic activity degradation in the detergent wash medium. Without being limited by any theory, it is believed that oxidizing moieties in the detergent wash medium are responsible for oxidizing the amine, ammonium and sulhydryl functionalities of amine, ammonium and/or sulhydryl containing amino acids in the enzyme and that this oxidation accounts for at least part of the loss of enzymatic activity. It is further believed that enzyme protecting agents containing one or more enzyme protecting functional groups selected from the group consisting of amine, ammonium and sulhydryl groups (e.g., $-NH_3$, $-NH_4^+$, -SH groups) protect the enzyme from enzymatic activity degradation by offering alternative sites for oxidation by the oxidizing moieties. That is to say that the presence of a large number of these functionalities in the detergent wash medium will result in enzyme protection because, by shear number of such functionalities, oxidizing agents present in the wash medium will preferentially oxidize these functionalities rather than oxidizing oxidizable functionalities n the

enzyme. Accordingly, such functional groups are described herein as enzyme protecting functional groups.

In this regard, the intimate contact of the enzyme protecting agent with the enzyme which results from combining these components in the granule is essential to this invention because, when the granules are initially added to and dissolved in the detergent wash medium, the concentration of the enzyme protecting agent in the microenvironment of the dissolving granule and accordingly, the dissolving enzyme, is extremely high. Again, without being limited to any theory, it is believed that this initial very high concentration of the enzyme protecting agent in the microenvironment of the enzyme prevents any significant oxidation of the enzyme by those oxidizing groups found in the detergent wash medium. In contrast, if the enzyme and enzyme protecting agent are merely combined into the detergent composition as separate components,this high concentration of enzyme protecting agent in the microenvironment of the enzyme cannot form and accordingly, significantly less protection is accorded to the enzyme.

In view of the above, the concentration of the enzyme protecting agent necessary to impart protection to the enzyme in the detergent wash medium is related to the number of enzyme protecting functional groups present on the protecting agent molecule. That is to say that a smaller quantity of protecting agent containing a high number of enzyme protecting functionalities per molecule is required to provide the same level of protection as compared to protecting agents containing a small number of enzyme protecting functionalities per molecule, (e.g., approximately one-half the quantity of ethane dithiol, $HSCH_2CH_2SH$, is required t achieve th same protecting effect as is achieved by using a full quantity of ethane

thiol, CH_3CH_2SH). Accordingly, in the present invention, the relevant criteria for the enzyme protecting agent concentration is, in fact, the concentration of the protecting functionalities which can be defined in terms of the number of mols of such functionalities present.

In general, the concentration of the enzyme protecting agent employed is an amount effective to retard the loss of enzymatic activity of the enzyme in the wash medium. Preferably, the enzyme protecting agent is selected so as to provide at least about 1 micromols/liter of the enzyme protecting functional groups, and preferably 40 micromols/liter of the enzyme protecting functional groups, in the detergent wash medium. Even more preferably, the concentration of the enzyme protecting agent is selected so as to provide at least about 100 micromols of enzyme protecting functional groups per liter of detergent wash medium, and still even more preferably, at least about 200 micromols of enzyme protecting functional groups per liter of detergent wash medium.

While the enzyme protecting agents employed herein include some of the same components heretofore employed as chlorine scavengers, the amount or concentration of enzyme protecting agent which imparts improved resistance to loss of enzyme activity in the detergent wash medium is preferably greater than that required to scavenge chlorine. That is to say that such use is an improvement over such previous uses of chlorine scavengers insofar that when used at a higher concentration in the detergent wash medium, these scavengers additionally remove other oxidizing moities which thereby improves the enzymatic activity degradation resistance in the detergent wash medium.

Moreover, as noted above, the present invention also requires that the enzyme protecting agent be intimately combined with the enzyme in the form of granules.

As noted above, the enzyme protecting agent protects enzyme activity, thereby ensuring that the enzyme will maintain high levels of activity over time in the detergent wash medium. In this regard, the terms "protect enzyme activity", "enzyme activity degradation resistance" and "retard the loss of enzyme activity" mean that the loss of enzyme activity in the detergent wash medium is less than that encountered without the use of an enzyme protecting agent. Empirically, enzyme activity degradation resistance can be measured by comparing the percent loss of enzyme activity in a detergent wash medium with and without the presence of a enzyme protecting agent over the same period of time. These results are then reported as a fraction wherein the numerator is the percent loss of enzyme activity in the detergent wash medium containing an enzyme protecting agent and the denominator is the percent loss of enzyme activity in the same detergent wash medium but in the absence of an enzyme protecting agent. Fractions of about 0.8 or less are deemed to be enzymatic activity degradation resistant, i.e., the enzyme activity is protected. Fractions of about 0.6 or less are preferred; with fractions of about 0.4 or less being particularly preferred.

The granules of this invention are particularly suited for use in a detergent composition. As noted above, when so used, the granule will generally comprise from about 0.002 to about 20 weight percent and preferably from about 0.1 to about 10 weight percent of the total detergent composition. The detergent comp sition will additionally contain a surface active agent, i.e., a surfactant. The surface active agent employed in the detergent composition includes anionic, non-ionic and

ampholytic surfactants well known for their use in detergent compositions.

Suitable anionic surfactants for use in the detergent composition of this invention include linear or branched alkylbenzenesulfonates; alkyl or alkenyl ether sulfates having linear or branched alkyl groups or alkenyl groups; alkyl or alkenyl sulfates; olefinsulfonates; alkanesulfonates and the like. Suitable counter ions for anionic surfactants include alkali metal ions such as sodium and potassium; alkaline earth metal ions such as calcium and magnesium; ammonium ion; and alkanolamines having 1 to 3 alkanol groups of carbon number 2 or 3.

Ampholytic surfactants include quaternary ammonium salt sulfonates, betaine-type ampholytic surfactants, and the like. Such ampholytic surfactants have both the positive and negative charged groups in the same molecule.

Nonionic surfactants generally comprise polyoxyalkylene ethers, as well as higher fatty acid alkanolamides or alkylene oxide adduct thereof, fatty acid glycerine monoesters, and the like.

Suitable surfactants for use in this invention are disclosed in British Patent Application No. 2 094 826A, the disclosure of which is incorporated herein by reference.

The surfactant is generally employed in the detergent compositions of this invention in a cleaning effective amount. Preferably, the surfactant is employed in an amount from about 1 weight percent to about 95 weight percent of the total detergent composition and more preferably from about 5 weight percent to about 45 weight percent of th total detergent composition.

In addition to the surface active agent, the cellulase, and the cellulase protecting agent, the detergent

compositions of this invention can additionally contain the following components:

Cationic surfactants and long-chain fatty acid salts

Such cationic surfactants and long-chain fatty acid salts include saturated or unsaturated fatty acid salts, alkyl or alkenyl ether carboxylic acid salts, α-sulfo-fatty acid salts or esters, amino acid-type surfactants, phosphate ester surfactants, quaternary ammonium salts including those having 3 to 4 alkyl substituents and up to 1 phenyl substituted alkyl substituents. Suitable cationic surfactants and long-chain fatty acid salts are disclosed in British Patent Application No. 2 094 826 A, the disclosure of which is incorporated herein by reference. The composition may contain from about 1 to about 20 weight percent of such cationic surfactants and long-chain fatty acid salts.

Builders

A. Divalent sequestering agents.

The detergent composition may contain from about 0 to about 50 weight percent of one or more builder components selected from the group consisting of alkali metal salts and alkanolamine salts of the following compounds: phosphates, phosphonates, phosphonocarboxylates, salts of amino acids, aminopolyacetates high molecular electrolytes, non-dissociating polymers, salts of dicarboxylic acids, and aluminosilicate salts. Suitable divalent sequestering agents are disclosed in British Patent Application No. 2 094 826 A, the disclosure of which is incorporated herein by reference.

B. Alkalis or inorganic electrolytes

The detergent composition may contain from about 1 to about 50 weight percent, preferably from about 5 to about 30 weight percent, based on the composition of one or more alkali metal salts of the following compounds as the alkalis or inorganic electrolytes: silicates, carbonates and sulfates as well as organic alkalis such as triethanolamine, diethanolamine, monoethanolamine and triisopropanolamine.

Antiredeposition agents

The detergent composition may contain from about 0.1 to about 5 weight percent of one or more of the following compounds as antiredeposition agents: polyethylene glycol, polyvinyl alcohol, polyvinylpyrrolidone and carboxymethylcellulose.

Among them, a combination of carboxymethyl-cellulose or/and polyethylene glycol with the cellulase composition of the present invention provides for an especially useful dirt removing composition.

For removing the decomposition of carboxymethyl-cellulose by the cellulase in the detergent, it is desirable that carboxymethylcellulose is granulated or coated before the incorporation in the composition.

Bleaching agents

The use of certain enzymes, e.g., cellulase, in combination with a bleaching agent such as sodium percarbonate, sodium perborate, sodium sulfate/hydrogen peroxide adduct and sodium chloride/hydrogen peroxide adduct or/and a photo-sensitive bleaching dye such as zinc or aluminum salt of sulfonated phthalocyanine further improves the deterging effects.

Bluing agents and fluorescent dyes

Various bluing agents and fluorescent dyes may be incorporated in the composition, if necessary. Suitable bluing agents and fluorescent dyes are disclosed in British Patent Application No. 2 094 826 A, the disclosure of which is incorporated herein by reference.

Caking inhibitors

The following caking inhibitors may be incorporated in the powdery detergent:p-toluenesulfonic acid salts, xylenesulfonic acid salts, acetic acid salts, sulfosuccinic acid salts, talc, finely pulverized silica, clay, calcium silicate (such as Micro-Cell of Johns Manville Co.), calcium carbonate and magnesium oxide.

Masking agents for factors inhibiting the cellulase activity

Certain enzymes, e.g., cellulase, are deactivated in some cases in the presence of copper, zinc, chromium, mercury, lead, manganese or silver ions or their compounds. Various metal chelating agents and metal-precipitating agents are effective against these inhibitors. They include, for example, divalent metal ion sequestering agents as listed in the above item with reference to optional additives as well as magnesium silicate and magnesium sulfate.

In regard to the enzymes, certain components can act as inhibitors. For example, with cellulase, it is known that cellobiose, glucose and gluconolactone act sometimes as the inhibitors. It is preferred to avoid the co-presence of these inhibitors with the enzyme as far as possibl . In the event that co-presence is unavoidable, it is n cessary to avoid the direct contact of the inhibitors with the enzyme by, for example, coating them.

Long-chain-fatty acid salts and cationic surfactants can act as the inhibitors of some enzymes, e.g., cellulase, in some cases. However, the co-presence of these substances with the enzyme is allowable if the direct contact of them is prevented by some means such as tableting or coating.

The above-mentioned masking agents and methods may be employed, if necessary, in the present invention.

Enzyme-activators

Certain enzymes, e.g. cellulase, are known to be activated by the presence of materials referred to as activators. For cellulase, the activators vary depending on variety of the cellulases. In the presence of proteins, cobalt and its salts, magnesium and its salts, and calcium and its salts, potassium and its salts, sodium and its salts or monosaccharides such as mannose and xylose, the cellulases are activated and their deterging powers are improved remarkably.

Antioxidants

The antioxidants include, for example, tert-butylhydroxytoluene, 4,4′-butylidenebis(6-tert-butyl-3-methylphenol), 2,2′-butylidenebis(6-tert-butyl-4-methylphenol), monostyrenated cresol, distyrenated cresol, monostyrenated phenol, distyrenated phenol and 1,1-bis(4-hydroxyphenyl)cyclohexane.

Solubilizers

The solubilizers include, for example, lower alcohols such as thanol, benzenesulfonate salts, lower alkylbenzenesulfonate salts such as p-toluenesulfonate salts, glycols such as pr pylene glycol, acetylbenzene-

sulfonate salts, acetamides, pyridinedicarboxylic acid amides, benzoate salts and urea.

The detergent composition of the present invention can be used in a broad pH range of from acidic to alkaline pH. Preferably, the detergent composition is employed in a neutral/alkaline pH and more preferably in a neutral/alkaline pH of from pH 7 to 10.

Aside from the above ingredients, perfumes, buffers, preservatives, dyes and the like can be used, if desired, with the detergent compositions of this invention.

When the detergent composition is added to an aqueous solution so as to produce a cleaning effective concentration of a surface active agent, the resulting aqueous solution is sometimes referred to herein as a "detergent wash medium".

When a detergent base used in the present invention is in the form of a powder, it may be one which is prepared by any known preparation methods including a spray-drying method and a granulation method. The detergent base obtained particularly by the spray-drying method and/or spray-drying granulation method are preferred. The detergent base obtained by the spray-drying method is not restricted with respect to preparation conditions. The detergent base obtained by the spray-drying method is hollow granules which are obtained by spraying an aqueous slurry of heat-resistant ingredients, such as surface active agents and builders, into a hot space. The granules have a size of from 50 to 2000 micrometers. After the spray-drying, perfumes, enzymes, bleaching agents, inorganic alkaline builders may be added. With a highly dense, granular detergent base obtained such as by the spray-drying-granulation method, various ingredients may also be added after the preparation of the base.

The methods of the present invention are carried out by incorporating into a detergent composition the requisite amount of the granules of this invention. Thus, when such a detergent composition is added to water, the resulting aqueous solution will contain the required amount of the enzyme protecting agent in intimate contact with the enzyme so that immediately upon dissolution, the resulting microenvironment will contain the enzyme and a very high concentration of the enzyme protecting agent so as to protect the enzyme from loss of enzymatic activity over time.

Lastly, it is contemplated that use of the enzyme protecting agent in enzyme containing solutions other than detergent wash medium will also result in the protection of the enzyme activity in such media. Such other media include, for instance, industrial enzyme solutions (e.g., cellulase solutions used for food processing, textiles, etc.) and the like. It is further contemplated that in such other medium, the concentration of the enzyme protecting agent necessary to achieve protection of the enzyme activity in such media is as described above for detergent wash media.

The following example is offered to illustrate the present invention and should not be construed in any way as limiting the scope of this invention. This example employs cellulase as the enzyme for illustrative purposes. However, it is understood that other enzymes could be used in place of cellulase by merely substituting such other enzyme for cellulase.

EXAMPLE

A Uni-Glatt laboratory fluidized-bed spray-coater is charged with 1210 grams of non-pareils cores or seeds having a diameter of 425 to 850 microns. A 1.05 liter aqueous cellulase concentrate (cellulase available as Cytoclase 123 from Genencor International, 180 Kimball Way, South San Francisco, CA 94080) containing 170 grams/liter protein and 25% total solids is sprayed onto the fluidized cores at a spray rate of about 10 ml/min with an inlet temperature of 45° to 62°C and an outlet temperature of 38° to 46°C. At the end of the enzyme application, 1466 grams of granules are recovered, representing a 21.2% weight gain over the non-pariel core. The resulting granules are screened to provide granules between 425 and 1180 microns, a total of 1411 grams. The recovery of protein in the 425 to 1180 micron granules is 87.0% of the protein occurring in the cellulase concentrate applied. The protein content of these granules is 110 grams/kilogram. These granules are hereinafter referred to as "Granule A".

Granule A (706 grams) is then charged into a Uni-Glatt fluidized-bed spray-coater and coated with 37 grams of ammonium sulfate dissolved in 100 mls final volume of deionized water. The ammonium sulfate solution is sprayed onto the fluidized granules at around 10 mls/min with an inlet temperature of 50° to 60°C and an outlet temperature of 40° to 46°C. These granules are screened to provide granules between 425 and 1180 microns, a total of 727 grams. The recovery of protein in the 425 to 1180 micron granules is 98.1% of the protein occurring in the Granule A material charged into the fluidized-bed spray-coater. The protein content of these granules is 105 grams/kilogram. These granules are hereinafter r f rred to as "Granule B".

A fully formulated commercially available powdered laundry detergent is separately formulated into two separate compositions. The first composition contains a sufficient amount of Granule A so as to provide 0.1 weight percent of cellulase (hereinafter "Composition A"); whereas the second composition contains a sufficient amount of Granule B so as to provide the same weight percent of cellulase (hereinafter "Composition B"). The same amount of Composition A and Composition B are added to separate washing machines each of which contains 17 gallons of water at 37°C. Immediately after addition, a 20 ml aliquot of each solution is withdrawn and the cellulolytic activity is measured, i.e., the zero point measurement. Additional aliquots are withdrawn at 3 minute intervals and the cellulolytic activity is measured for these samples as well. The cellulolytic activity of Composition B is significantly higher at all points measured (except for the zero point).

By following the procedure set forth above, other enzymatic protecting agents can be used in place of ammonium sulfate. Such agents include, for instance, ammonium citrate, urea, guanidine carbonate, guanidine sulfamate, thiourea dioxide, monoethanolamine, diethanolamine, triethanolamine, amino acids such as glycine, sodium glutamate and the like, proteins such as bovine serum albumin, casein, and the like, etc.

Likewise, other cellulase can be employed in place of Cytolase 123 by merely substituting such other cellulase for Cytolase 123 in the above example. For example, commercially available cellulases such as Celluclast (available from Novo Industry, Copenhagen, Denmark) and Rapidas (available from Gist Brocades, N.V., Delft, Holland) can be used as substitutes for Cytolase 123 in Example 1 above.

Additionally, other enzyme can be employed in place of cellulase by merely substituting such other enzymes for the cellulase in the above example. Such other enzymes include by way of example, proteases, lipases, cutinases, amylases, hemicellulases, β-glycosidases, glucose oxidases, cholesterol oxidases and the like.

WHAT IS CLAIMED IS:

1. A solid granular composition for use in a detergent wash medium comprising in granular form, an enzyme and an enzyme protecting agent having one or more enzyme protecting functional groups selected from the group consisting of amine, ammonium and sulhydryl functional groups.

2. A composition according to Claim 1 wherein said enzyme is incorporated into the core of the granules.

3. A composition according to Claim 2 wherein said enzyme protecting agent is incorporated into and/or onto said granules.

4. A composition according to Claim 1 wherein the granules contain from about 0.001 to about 50 weight percent of enzyme based on the weight of the granules and from about from about 0.1 to about 40 weight percent of enzyme protecting agent based on the weight of the granule and wherein the concentration of said enzyme protecting agent in said granule is an amount effective in retarding the loss of enzymatic activity in said detergent wash medium.

5. A composition according to Claim 4 wherein the concentration of said enzyme protecting agent in said detergent wash medium is sufficient to provide at least about 1 micromol of the cellulase protecting functional groups per liter of detergent wash medium.

6. An enzyme containing solid detergent composition for use in a detergent wash medium comprising a cleaning effective amount of a surface active agent and granules comprising an enzyme and an enzyme protecting agent having one or more enzyme protecting functional groups selected from the group consisting of amine, ammonium and sulhydryl functional groups wherein said granules comprise from about 0.002 to 20 weight percent of the detergent composition.

7. A detergent composition according to Claim 6 wherein said enzyme is incorporated into the core of the granules.

8. A detergent composition according to Claim 7 wherein said enzyme protecting agent is incorporated into and/or onto said granules.

9. A detergent composition according to Claim 8 wherein the granules contain from about 0.001 to about 50 weight percent of enzyme based on the weight of the granules and from about from about 0.1 to about 40 weight percent of enzyme protecting agent based on the weight of the granule and further wherein the concentration of said enzyme protecting agent in said granule is an amount effective in retarding the loss of enzymatic activity in said detergent wash medium.

10. A detergent composition according to Claim 6 wherein the concentration of said enzyme protecting agent is selected so as to provide at least about 1 micromol of the enzym protecting functional groups per lit r of d tergent wash medium.

11. A method of retarding loss of enzymatic activity in a detergent wash medium which method comprises adding to aqueous solution:

(a) a cleaning effective amount of a surface active agent so as to form said detergent wash medium; and

(b) granules comprising an enzyme and an enzyme protecting agent containing one or more enzyme protecting functional groups selected from the group consisting of amine, ammonium and sulhydryl functional groups wherein said granules comprise from about 0.002 to 20 weight percent based on the weight of the detergent composition.

12. A method according to Claim 11 wherein said enzyme is incorporated into the core of the granules.

13. A method according to Claim 12 wherein said enzyme protecting agent is incorporated into and/or onto said granules.

14. A method according to Claim 13 wherein the granules contain from about 0.001 to about 50 weight percent of enzyme based on the weight of the granules and from about from about 0.1 to about 40 weight percent of enzyme protecting agent based on the weight of the granule and further wherein the concentration of said enzyme protecting agent in said granule is an amount effective in retarding the loss of enzymatic activity in said detergent wash medium.

15. A method according to Claim 11 wherein the concentration of said enzyme protecting agent is selected so as to provide at least about 1 micromol of the enzyme protecting functional groups per liter of detergent wash medium.

INTERNATIONAL SEARCH REPORT

International Application No PCT/US 91/03044

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl.5 C 11 D 3/386

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl.5	C 11 D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	EP,A,0170360 (NOVO INDUSTRI) 5 February 1986, see page 6, lines 16-20; claims 1,6,8; page 10, lines 3-5 ---	1-15
X	FR,A,2023628 (PROCTER & GAMBLE) 21 August 1970, see page 7, lines 24-33; claims; examples ---	1-4,6-9 ,11-14
X	DE,A,2512044 (UNILEVER) 25 September 1975, see claims 1,4; examples 2,4 ---	1-4,6-8 ,11-14
X	CHEMICAL ABSTRACTS, vol. 105, no. 26, December 1986, (Columbus, Ohio, US), see page 119, abstract 228951h, & JP-A-61 168 698 (SHOWA DENKO) 30 July 1986, see abstract ---	1-3,6-8
X	DE,A,1958105 (KNAPSACK) 19 May 1971, see claims 1-3,5 --- -/-	1-3,6-8 ,11

° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
06-09-1991	01. 10. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	miss.T.MOLLENSEN

Form PCT/ISA/210 (second sheet) (January 1985)

III. D CUMENTS CONSIDERED T BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	FR,A,2099349 (NOVO TERAPEUTISK LAB.) 10 March 1972, see claims 1,5,7; examples 8,14 ---	1-4
X	EP,A,0271004 (KAO) 15 June 1988, see page 24, line 16 - page 25, line 11; page 28, lines 1-8; claim 1 (cited in the application)	1
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9103044 SA 48195

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 19/09/91
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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